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we neglect our present opportunities to study the anthropoids, our children's children will condemn us for neglecting invaluable opportunities. To-day, the chimpanzee, the orang-outang, the gibbon, as well as many species of monkey, are at hand for observation. A generation or two hence, many of the primates may be extinct. Should we not, in the interests of genetics, whether we be concerned primarily with problems of structure or of function, see to it that we adequately use, for the purpose of advancing human welfare, our present primate materials?

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SWEATING THE SCIENTIST¹

IN the four last numbers of *Science Progress* a notice has been inserted asking for information on the emoluments of scientific workers; and a considerable number of interesting replies have been received. They are not numerous enough to form a basis for any statistical investigation of the subject—which it is hoped may be attempted later on when more evidence has been collected; but the replies received, combined with information which may be otherwise obtained, suffice to prove the low scale of payment given throughout the British Empire for such work.

The term "scientific worker" includes, according to the notice, all salaried workers—that is, men of all grades, namely, research students, assistants, professors, directors of laboratories, and other fully paid workers, and also half-time and whole-time workers. The duties generally include teaching and the administrative charge of university departments, museums and special laboratories. The lowest scale of pay mentioned in the replies is £85 a year for half-time work; but it is notoriously that a large number of such workers, espe-

cially in medical subjects, are paid nothing at all. The pay of junior posts (which are also sometimes unpaid) rises from about £120 to £200, £250 and, rarely, £300 a year. These are of course not so important as the upper scales of pay for full-time professorships and permanent appointments. For the latter, the highest pay mentioned in the replies amounts to £850 a year, with a small pension (Ceylon). The next highest are salaries of £750, both in South Africa, and one of £500 in Canada, with small pensions generally contributed to by the holders of the appointments. It is well known that many professorships in Britain yield £600 a year, with very small contributory pensions. In no cases do there appear to be any arrangements for family pensions in the event of the holders' death—such as are often provided in the public services; nor insurance against illness or accident. Notoriously, very few even of the highest posts receive a salary touching or exceeding £1,000 a year; and in nearly all cases the pensions are contributory and are of a very small amount—retirement being often compulsory at the age of 60 or 65 years. Progressive rises of pay are also seldom provided for; so that a man who obtains an appointment when comparatively young can seldom hope for any increase during the rest of his life. Lastly, payment is laid down at many universities according to a flat rate, or according to fixed endowments which depend upon the funds originally allotted—so that no provision is made for retaining specially good men. In some cases holders of fully paid appointments are able to increase their emoluments by outside work. Many medical professorships are quite unpaid.

The rates of pay must be judged by the locality in which they are given. Thus £750 in South Africa is worth very much less than that sum in Britain, the cost of living being perhaps twice as great. A correspondent from Canada remarks that a salary of £800 a year in England is equivalent only to about £600 a year there, and is not sufficient for a professor. "A member of a learned community," he says, "can not live in a back street like a laborer, and if he takes an unfurnished house

¹ An editorial article printed in the April number of *Science Progress in the Twentieth Century: A Quarterly Journal of Scientific Work and Thought*, edited by Sir Ronald Ross.

in a good locality here the rent will be about a quarter of his income. . . . The smallness of income results, in my case, in my being unable to buy books, subscribe to scientific journals, or join all the learned societies I ought, or to travel to see other universities." Similar complaints are made from elsewhere; and the conditions in Britain are notorious.

Of course, very junior posts are generally financed by scholarships; and are naturally not highly paid because the holders are young men who are, practically, being apprenticed to their labors. The senior posts are those which must be considered in drawing any comparison between the payment for scientific work and other lines of effort; and even in this respect other conditions besides the payment must be taken into account. On the whole, however, such comparison leads to a very unfavorable conclusion regarding the present payment of scientific workers in Britain. It is bad, compared even with the Church. In middle posts, the salaries may be slightly higher; but in academical life the incumbents are obliged to live in towns and are rarely provided with housing. The highest appointments open in science certainly seem to be paid much less than the highest appointments in the Anglican Church—though the latter figures can not be very easily ascertained; and, at least, no scientific men have a seat in the House of Lords by virtue of their office or work. The highest salaries for scientific work are very much less than those given in the Army and Navy—which reach to £4,000 or £5,000 a year, and probably more when certain allowances are added. The scientific and academical sides of the medical profession show a similar state of affairs when compared with the clinical side—the incomes of the former seldom if ever exceeding £1,000 a year, while those of the latter are well known to run to many times that amount, especially in surgery. Compared with the law, science stands nowhere at all in Britain, either in payment or in position. The disparity is still greater in comparison with "business"; and the enormous fortunes made in innumerable directions by manufacturers, shipowners, retail and wholesale traders, vend-

ors of registered articles, financiers, and so on, would in many single cases cover the whole funds allotted to science throughout the great British Empire. Even certain branches of art, such as the drama, singing and acting, have a large advantage compared with scientific work.

It is in no grudging spirit that men of science will draw such comparisons. That good pay should be given for good work is an elementary principle governing all lines of effort; but another principle must be held in view—that, if possible, payment should bear some proportion to the value of the kind of work done. We pay an architect or a general more than we pay the bricklayer or the soldier, because the labors of the former are the more important; and the same principle should carry weight in comparisons of the emoluments of the several professions. In the two previous numbers of *Science Progress*, a survey of the value of scientific work to the world has been attempted. It is probably of greater advantage to the world than any other line of effort. Science has become our premier industry, and governs every other industry just as the work of the architect governs that of the individual bricklayers. The world receives not only "fairy tales" from science, but also the most wonderful fairy gifts—a greater knowledge of the universe in which we live, a greater power over nature and over barbarism, greater precision in invention, in the treatment and prevention of disease, and in our manner of judging regarding all matters under discussion. Can it be truly said that the labors of any other professions are so valuable to mankind? Where the priest, the clinician, and the lawyer do good service to the few people surrounding them, and the soldier, sailor and politician do good service for their country, the discoverer confers benefits upon the whole world, and not for the present generation only, but for all times. We have already argued the case. Mathematics, chemistry, physics, physiology and pathology have practically built up all those great and wonderful additions which modern civilization has added to the civilization of the past, and,

with their sisters of the arts, have made a fitting palace for what ought to be a higher race. Yet the payment of the highly qualified men of the same age who were not so unwise and who are still perfecting them is less than that given to all the other professions, and, compared with the value of the work, is almost infinitely less. Indeed it would appear that the second principle enunciated above is just the opposite of the truth—that work is paid for in the inverse ratio of its value: and this is not a mere cynical gibe, but the actual truth. The greatest benefits which the world has ever received, that is, those which it has received from science, literature, art and invention, have generally been paid for not at all.

But it may now be said that the scale of payment for science is purely a question of supply and demand. That is so—and the same principle governs the case of sweated industries of all kinds. In the latter, the employer exploits the necessities of a crowded and poor population in order to have his work done at the cheapest rate. As regards science, however, the employer is the public itself, and the sweated laborer is the highest type of intellect in the country. The process by which the sweating is rendered possible is something as follows: Young graduates, fired with enthusiasm for science or with the desire of investigating some question which has occurred to them, take scholarships or poorly paid research-studentships. At first, while they are young, everything goes well with them; but after some years they find that the shoe begins to pinch. Then, unfortunately, it is too late. They have lost the time which they should have used in perfecting themselves for their proper profession, whatever that may be—in which they have already been outpaced by men who formed these sciences in the past or so high-minded as themselves. The opening which they may have taken five years previously is now closed to them; and they are compelled to spend the rest of their life under the paralyzing influences described above. This also is the actual fact; and it must evidently produce a disastrous influence,

not only on the men who suffer, but also upon the great studies to which they devote themselves. The most capable graduates are already beginning to perceive the truth and to avoid the toils. The elder men, seeing that investigation leads to nothing, tend to interest themselves only in teaching, compilation of text-books, and attendance upon committees. The enthusiasm and concentration which when found together are called genius become impossible; and we look almost in vain for that high devotion to science which is the only quality she rewards with success. And the punishment does not really fall so heavily upon the worker himself—his enthusiasm for science may quite possibly compensate him for such troubles as those mentioned above. But the punishment falls upon his family; it falls upon the institution which employs him; it falls upon the nation which allows such a thing; and it falls upon science herself.

Besides the low rate of pay given, there are, in this country at least, many small abuses attached to high intellectual work. Even such funds as may be allotted are not used to the best advantage. Large portions of the income of many institutions are given to the maintenance of more or less useless pursuits—which were useful pursuits in the past, but no longer serve the world, or indeed serve it only in a negative sense. Originality and success in research do not receive their due place in selection for appointments. The best paid posts are seldom given for the best work done, but rather for qualities which are of little account—popularity, eloquence, text-book knowledge, private influence, and skill in the arts of time-service. For obvious reasons it is impossible to cite examples, but the fact remains. Of the few Britons of to-day who have done world-service, how many hold the leading public posts even in their own domain? We appear to judge men, not by the work which they have done, but by the work which we may imagine, from their appearance, that they may do if we give them an opportunity. How many of our most distinguished writers, for example, have received academic posts for teaching their own art? And how many of our most

distinguished men of science are now heads of British universities?

Many other disabilities are frequently complained of and resented by scientific workers. The whole system of filling appointments requires careful reconsideration. Some years ago an excellent article on the subject of advertising vacant appointments appeared in the *University Review*. The advertisements are often issued when the post has already been practically allotted—simply as a kind of show to prove impartiality on the part of the advertising body. The result is that numbers of candidates are tempted to put themselves to great trouble and some expense, and are kept upon the tenterhooks of doubt for months. Another abuse, still allowed for academical and hospital posts, is the necessity of canvassing for appointments—a very objectionable system which compels the unfortunate applicant to visit a number of persons with whom he is not acquainted and who often have no knowledge of his subject, and to parade his virtues before them in competition with other unfortunates who are in the same case. We heard some time ago of a distinguished mathematician who was obliged to sue humbly for a poorly-paid post before two local tradespeople—and who was not accepted. Can anything show more clearly than such a state of affairs the low position held by high work in Britain? Indeed the whole system so frequently adopted here of allowing scientific institutions, hospitals and even universities, to be governed by committees of persons of whom many have no qualifications for the work, who are often not even moderately distinguished in any line, but who find their profit in the position, is thoroughly discreditable; and recent disputes in the management of certain hospitals have illustrated the defect.

We have recently started the habit of giving our rare professorships to foreigners—not really because the foreigners are the best men for the posts, but because the institution concerned likes to obtain a reputation for magnanimity. Yet foreign nations are not so generous to us. As a matter of fact we buy, not in the cheapest market, but in the dearest one;

and do so, not from motives of business, but merely out of ostentation. The same indifference to work done is often manifested in the honors given by many learned bodies. We see the academic laurel placed upon the brows of soldiers, sailors and politicians—men who have perhaps done great service in their own line, though not in the line for which such honors should be reserved. The case can of course be argued—as all bad cases can; but it is really a matter of clean taste. Academic honors are meant to promote great world-service; and it is a sign of national degeneracy when they are given for anything lower. One would think that our universities would lead the way in this respect, but it is not so. Some years ago a distinguished colonial premier refused an academic honor on these grounds, and attained great honor by doing so. Few are the struggling workers or the struggling causes which have benefited by the powers in the hands of the great learned bodies. To add grist to their own mill by subserviency to popular idols appears too often to be their chief desire; and where a great worker is honored by them, he is generally a foreigner. A still lower stage, however, has already been reached—where a learned body decorates itself!

We may now ask, what exactly does the British Empire do, as a state, for science, or indeed for any of the higher forms of intellectual effort? Parliament allots £4,000 a year to one learned society, and another £1,000 a year for publications—a magnificent endowment! It allows also occasional small grants to other institutions; and all these are doled out for the expenses of special researches. The larger grants which it gives to universities are devoted chiefly to teaching—a very small proportion ever being really available for investigation. Very little of the money goes to the workers themselves, either to increase their pay or to reward them for services rendered; and the state seems to think that if it provides their test tubes and microscopes it has done enough. In many countries the government wisely pays members of certain academies; but in Britain, not only is this not done, but the state actually exacts gratuitous

services from such members. For example, a government department wishes for expert advice on some matter—it ought to form a commission of its own and honestly pay the expert members of it. Instead of doing this the government department goes to some learned society and asks it to advise on the scientific question at issue. The society is honored by the request, and obtains the advice gratis from its own members. Thus the government gets what it requires for nothing; the learned body is overpowered with the honor rendered to it; and the unfortunate worker is the loser. Such action is very common; unpaid government committees are now becoming the rule, and even reimbursement of traveling expenses is often boggled at. We heard the other day of a man who was actually found fault with for not attending a committee of this nature for which he was not paid. In other words, the state exploits the man of science on account of his enthusiasm for his work and his patriotism. The thing might be excused if the state were to give large funds for scientific work, but as it does not do so such action is extraordinary in its meanness and impropriety.

Many similar points may be cited. The board of education expends annually an enormous sum, amounting to nearly twenty millions a year, on low-class education; but what does it do for the greatest of educators—science, literature, art, drama, exploration, discovery, invention? As was pointed out in the last issue of *Science Progress*, the patent acts do not cover those whom they should most carefully protect, namely the men upon whose investigations nearly all inventions are founded. Quite recently the House of Commons has given itself payment amounting to over a quarter of a million pounds a year. Perhaps this is quite right; but may we not ask whether a small fraction of the money, properly devoted to scientific investigation in many lines, would not be of much greater benefit to the people than are the wranglings of party politicians over questions which will never be honestly decided because they are never honestly considered? Still more recently the state has given, very wisely, £57,000

a year out of the insurance fund for medical researches. It was suggested at the committee which organized the management of this expenditure that a large prize should be available out of the fund for important discoveries; but the money actually offered has now been reduced to a maximum of £1,000. In other words, if a private medical man were to discover the means of prevention or cure of tuberculosis or cancer—which he would not be likely to do without spending years of study over the theme, and probably losing his practice in consequence of his work—his only reward would be £1,000! The discoverer will not be paid; and yet the country hopes to have discoveries achieved! And this brings us to what is really the crowning defect of the national attitude towards high effort of such kinds, namely, that it makes no attempt whatever to pay for any benefits, however great, which it receives from individuals. A successful soldier may indeed receive a handsome donation, and many politicians obtain large pensions; but the highest services in the domains of science, literature and art are not deserving of reward!

The net result may of course be foretold from these data. There is much petty science, petty literature and petty art; but the more arduous labors which require the devotion of a lifetime are becoming increasingly difficult. The man of science is now exactly in the position in which writers and inventors found themselves before the copyright and patent acts were passed. He is never the master in his own house; he is the slave to institutions which “run him” for what he is worth; and is seldom able to spend his time in the exercise of the lofty gift which nature has given him. Still worse, the most capable minds are at the outset turned away from fields in which their efforts are likely to be of the highest value to humanity.

All this really springs from the curious and stupid attitude of the public towards all forms of intellectual effort. It seems to take no interest in such effort. Politics, game-playing and picture-shows are the things which amuse it. The great worker is a mere book-

worm, or a plodder, or a crank. But the truth is that, just as individuals have duties to perform to their country, so have countries duties to perform to the civilized world. It is the duty of every nation to participate in the discovery of the laws of nature, to ascertain the cause of disease, to enhance the powers of man, and to widen the range of his vision. What does Britain do to fulfil this duty? She still has great workers, it is true; but their work springs from themselves, and not from the nation. The country does not perform the duty referred to. It has become like a tradesman who has reached great wealth by the exercise of inferior arts, but who spends it on amusements, pleasures and the ostentation of charity, without sparing a penny for higher objects. This figure may at least be reached as a rough integration of the general complex formulæ of our present condition. Behind all there is a shadow: for nations, like individuals, must remain efficient.

EFFECT ON THE PROPAGATION OF ELECTRIC WAVES OF THE TOTAL ECLIPSE OF THE SUN, AUGUST 21, 1914

THE committee for radiotelegraphic investigation of the British Association for the Advancement of Science calls attention to the fact that the forthcoming total eclipse of the sun affords an exceptional and important opportunity of adding to existing knowledge of the propagation of electric waves through air in sunlight and in darkness, and across the boundaries of illuminated and unilluminated regions. The eclipse will be total along a strip extending from Greenland across Norway, Sweden, Russia and Persia to the mouths of the Indus. In Russia the duration of totality will be a little more than two minutes.

There are two main points calling for investigation during the eclipse. In the first place, the propagation of signal-bearing waves through air in the umbra and penumbra will probably obey laws different as regards absorption and refraction from those obeyed in illuminated air. In the second place, the strength, frequency and character of natural electric waves, and of atmospheric discharges,

may vary. The variations may occur either because the propagation of natural waves from distant sources is facilitated or impeded by the eclipse, or, possibly, because the production of natural electric waves or atmospheric discharges is for some unknown reason affected by the eclipse.

These points have previously been investigated to only a slight extent. The observers of signals during the solar eclipse of April 17, 1912, nearly all agreed that the strength of the signals was greater during the eclipse than an hour before or after. There was only one special observation of strays during the same eclipse, when very pronounced and remarkable variations were recorded during the passage of the shadow-cone across Europe.

To investigate the propagation of signals across the umbra it will be necessary to arrange for wireless telegraph stations on either side of the central line of the eclipse to transmit signals at intervals while the umbra passes between them. This transit of the umbra occupies about two minutes. It is thus very desirable that the Scandinavian and Russian stations should transmit frequently throughout several minutes before, during and after totality. But stations other than those favored by their proximity to the central line should endeavor to keep a complete record of the variations of signals during the eclipse. Stations in Europe west of the central line and stations in the Mediterranean and in Asia Minor may find noticeable changes in the strength of signals, particularly long distance signals, between the hours of 10 A.M. and 3 P.M., Greenwich time; and it is probable that the stations of India and East Africa, and ships in the Indian Ocean, may feel the effect of the penumbra in the afternoon. On the other hand, ships in the Atlantic, and fixed stations in Eastern Canada and the United States, will probably be affected by the penumbra in the early morning. At Montreal the eclipse (partial) is at its greatest phase at 5:52 A.M. standard time. It is possible that the eclipse may have some influence even when it is invisible.

The investigation of strays is of as great